4.4.3.2.2.2 Interference from Feeder Link Transmissions of LEO Satellites to MSS (LEO or GSO) Mobile Earth Stations

Being a mobile service, the MSS service link systems operating in this band will undoubtedly use mobile Earth terminals that are small with a relatively wide antenna beam. This will dictate having relatively high power transmissions on the MSS service link to compensate for the relatively low antenna gain in the mobile terminal. These likely characteristics of the MSS service link will tend to minimize the interfering effect of the relatively low powered MSS feeder link transmissions into the MSS mobile Earth stations.

4.4.3.2.3 Summary of sharing in the 19.7-20.2 GHz band

In the frequency band 19.7-20.2 GHz that is planned for use by the ODYSSEY system for its space-to-Earth feeder link, the full 500 MHz is allocated on a co-primary basis to the Fixed-Satellite Service and the Mobile-Satellite Service in Region 2. In Regions 1 and 3, the Mobile-Satellite allocation is co-primary only at 20.1-20.2 GHz (and is secondary at 19.7-20.1 GHz). The ODYSSEY system requires slightly more than 100 MHz of the preferred band, and would be located at the top end of the frequency range.

In order for ODYSSEY to share with geostationary Fixed-Satellite Service systems, there are several steps that could be taken to prevent harmful interference from ODYSSEY satellites to geostationary FSS earth stations. Possible steps include attempting to ensure that ODYSSEY orbit ground tracks are such that the ODYSSEY satellites never pass through the beam of the geostationary FSS earth station, if it is possible from an orbital mechanics point of view; locating geostationary FSS earth stations outside the satellite antenna footprint of the ODYSSEY satellite (a solution that may be made more practical by virtue of the narrow beamwidth of the ODYSSEY feeder link satellite antenna); coordinating with geostationary FSS systems to mitigate or avoid potential harmful interference from instances of alignment (through control of power levels and avoidance of co-frequency operation).

Steps can also be taken to prevent harmful interference from geostationary FSS satellites to ODYSSEY earth stations, including attempting to avoid direct alignment between ODYSSEY satellites and the geostationary FSS earth stations; locating ODYSSEY feeder link earth stations outside the coverage area of the geostationary FSS satellite to gain isolation; and coordinating with geostationary FSS systems to mitigate or avoid potential harmful interference from instances of alignment (through control of power levels and avoidance of co-frequency operation).

Sharing with the MSS at 19.7-20.2 GHz should be made aided by the fact that there are relatively few MSS systems planned for the

band (i.e. ACTS an NORSTAR-I), and by the fact that geostationary MSS systems, unlike geostationary FSS systems, do not receive the added protection afforded by RR 2613. Any interference to ODYSSEY from MSS service links in the band will be minimized by the likely characteristics of the mobile earth stations. Interference from ODYSSEY feeder links to MSS service links will have to be coordinated.

4.4.4 Sharing between LEO systems

The previous sections have addressed sharing of the uplinks and downlinks of the 20/30 GHz FSS allocations which have been proposed for use by several proponents. These analyses have dealt with sharing between the LEO feederlinks, and GSO/FSS, GSO/MSS, Fixed, and LMDS services. Individual proponents have chosen different FSS spectrum to serve as feederlinks for reasons related to their system design. The flexibility of feederlink choice has been possible because of the existing U.S. policy wherein with few exceptions all of the FSS allocations are available for feederlinks from an allocation point of view.

No proponents proposing to use the 20/30 GHz FSS allocations have proposed to use the same allocations Were such a situation to come about, the most efficient approach to solving the problem would be to provide for additional band segments from available FSS spectrum for each applicant. This approach is warranted, because it has been shown that there are various techniques for LEO and GSO systems to co-exist in the FSS allocations, and sharing of the same FSS allocations at this frequency by multiple LEO Feederlinks has not been analyzed, could be quite complex, and introduce an additional level of constraints.

These comments apply both to the range 18.8-20.2 GHz (downlink) and 27.5-30.0 GHz (uplink).

4.5 Inter-satellite Links

Working Group 3 examined the need for rules with respect to the proposed use of radio links between satellites (inter-satellite links) of low Earth orbit satellite systems (LEO) in connection with this negotiated rule making.

The issues addressed included use of inter-satellite link allocations, sharing criteria and future use of inter-satellite link allocations.

4.5.1 System Requirements

4.5.1.1 Present Proposed Use

In its Low Earth Orbit satellite application to the FCC, Motorola Satellite Communications, Inc. proposes to use 200 MHz in

the existing allocation at 23.00-23.55 GHz for the IRIDIUM system inter-satellite links. No other applicant for an MSS/RDSS system has proposed use of the inter-satellite service in this band or anywhere else.

In view of NASA's intent to use the 22.55-23.55 GHz band for its TDRSS-II system, Motorola and NASA had several informal discussions on methods of sharing this inter-satellite service allocation. NASA subsequently sent Motorola a letter recognizing that Motorola plans to use the sub-band 23.18-23.38 GHz for interconnecting the IRIDIUM constellation of LEO satellite. (See MSSAC/IWG-3-10). NASA's letter also stated NASA's expectation that any future applications, for this purpose, will be licensed to use the 24.45-24.75 GHz band which will be available as of October 12, 1993, and confirmed that the 23.18-23.38 GHz band is the optimal place in the 22.55-23.55 GHz bands for the use proposed by Motorola.

4.5.1.2 Future Inter-satellite Link Requirements

The discussion in Working Group-3 clarified that LEO inter-satellite link use of the frequencies at 23.18-23.38 GHz would be compatible with the NASA TDRSS-II program. It was NASA's view, however, that further MSS applications proposing to use the inter-satellite service should look to the 24.45-24.75 GHz bands that were allocated for this purpose at WARC-92.

4.5.2 Inter-satellite Link Allocations

Preliminary to WARC-92 the principal allocations available for commercial inter-satellite links were the bands: 22.55-23 GHz, and 23-23.55 GHz. The pre-WARC-92 U.S. domestic allocation table is at Figure 4.5-1. As indicated in the table, these bands are allocated to the inter-satellite service and are shared on a co-primary basis with the fixed and mobile terrestrial services and with the broadcasting satellite service in Regions 2 and 3 for the 22.55-23.0 band. Footnote 879 urges that "all practicable steps be taken" to protect the spectral line observations of the radio astronomy service in the bands 22.81-22.86 GHz and 23.07-23.12 GHz from harmful interference". US Footnote 278 indicates that non-geostationary inter-satellite links are secondary to geostationary inter-satellite links in the 22.55-23.55 GHz band.

The U.S. proposals to WARC-92 advocated the addition of the inter-satellite Service on a co-primary basis with the fixed and mobile services in the allocation 21.7-22 GHz. The reason put forth in these proposals was "to provide an additional allocation for inter-satellite links between mobile-satellite service satellites." This specific proposal was not accepted, but an alternative allocation in the bands 24.45-24.65 GHz, and 24.65-24.75 GHz was agreed as a substitute. The 22.55-23.55 GHz band remained unchanged by WARC-92 except for the deletion of the

Broadcasting Satellite Service allocation at 22.55-23.00 in Regions 2 and 3.

4.5.3 Sharing with Fixed and Mobile

Finally, a question was raised regarding the necessity of sharing criteria between the fixed and mobile and inter-satellite link services. It was concluded that given the natural isolation between such services new criteria would not be necessary. Statements on this matter are contained in section 4.8 of the CCIR Report on the Technical and Operational bases for the World Administrative Radio Conference 1992 (See Attachment 4.2 - B). In addition WARC-92 in RR 2577-2580 adopted PFD limit (See Appendix 4.2-3 for the 22.55-23.55 GHz allocation which is met by the IRIDIUM system as shown in Figure 4.5-2.

4.5.4 Protection of Radio Astronomy

At present, only Motorola proposes to employ inter-satellite links within any portion of the ISS band 22.55-23.55 GHz, which also contains two spectral lines of interest to radio astronomy, 22.81-22.86 GHz and 23.07-23.12 GHz.

Motorola proposes to employ the band segment 23.18-23.38 GHz, which is sufficiently far removed from these spectral lines so that interference would be unlikely.

If, in the future, an MSS/RDSS operator proposes to use a band segment containing those spectral lines, the possibility of interference would have to be considered.

The PFDs reaching the surface of the Earth proposed by participants on the Working Group vary between -115 dBW/m2/MHz and -105 dBW/m2/MHz, depending on the angle of arrival.

Since the level at which harmful interference could be caused to these spectral line observations given in CCIR Report 224 is -216 dBW/m2/Hz, a reduction on the order of 41 to 51 dB would be required to protect radio astronomy sites from ISS signals reaching the surface of the Earth, depending on the spectral shape of the interfering signal.

A combination of satellite antenna discrimination and the use of ISS links which do not pass close to the limb of the Earth can provide a measure of isolation.

4.5.5 Summary of Inter-satellite Links

The issues addressed include use of inter-satellite link allocations, sharing criteria, and future use of inter-satellite link allocations. The analyses indicate that the use of the inter-satellite allocation at 23.18-23.38 GHz band was compatible with NASA's and Radio Astronomy's use of the 22.55-23.55 GHz

allocations, and the fixed service in the same allocations would be protected. However, it was indicated that NASA would prefer that further MSS applications proposing to use the inter-satellite service should look to the 24.45-24.75 GHz bands for this purpose.

Several new rules are proposed to provide for the inter-satellite service frequencies, coordination with government agencies, and certain sharing criteria.

5.0 Rules and Recommendations

The Working Group recommends that the Commission take account of the analyses that appear in this report and the working group reports attached hereto and act on the rules and recommendations which have received consensus support of the full Committee. A compilation of recommended rule changes appears in section 5.1. Recommendations other than specific rule changes are summarized in section 5.2.

5.1 Rules

5.1.3 Feeder Link and Inter-Satellite link Operations Rules

a. Add the definition of "mobile satellite service" to the definitions in Section 25.201, as set forth in Article 1 of the international Radio Regulations.

b. Revise Section 25.202(a)(2) to read as follows:

"(2) [The following frequencies are available for use by the mobile satellite service and the radiodetermination satellite service:

1610-1626.5 MHz
2483.5-2500 MHz]

Fixed-satellite services frequencies may be used for feeder links between radiodetermination or mobile satellites and feeder link (control center or gateway) earth stations, subject to the Rules in this subpart. In addition, the 5150-5216 MHz band (satellite-to-control center link) is available for radiodetermination satellite service feeder link use."

NOTE: THE RULE TEXT IN BRACKETS MUST BE REVIEWED AND APPROVED BY WORKING GROUPS 1 AND 2.

c. Add new Section 25.---, as follows:

"Additional Coordination Obligation for Non-Geostationary and Geostationary Satellite Systems in Frequencies Allocated to the Fixed-Satellite Service.

Operators of non-geostationary satellite systems that use frequency bands allocated to the fixed-satellite service for their feeder link operations shall coordinate their operations with operators of geostationary fixed-satellite service systems licensed by the Commission for operation in the same frequency bands. Operators of geostationary fixed-satellite service systems in the frequency bands that are licensed to non-geostationary satellite systems for feeder link operations shall coordinate their operations with the operators of such non-geostationary satellite systems."

d. In Sections 25.203 (c)(2)(vii), add the following clause to the end of the current text:

* * *

"taking into account the provisions of Section 25.253(a)(2) for earth stations operating with non-geostationary satellites."

e. Add new subsection (j) to Section 25.203, as follows:

"Applicants for non-geostationary MSS/RDSS feeder links in the bands 18.8-20.2 GHz and 27.5-30.0 GHz will indicate the frequencies and spacecraft antenna gain contours towards each feeder-link earth station location and will coordinate with licensees of other FSS and terrestrial-service systems sharing the band to determine geographic protection areas around each non-geostationary MSS/RDSS feeder-link earth station."

f. Add new subsection (k) to Section 25.203, as follows:

"An applicant for an earth station that will operate with a geostationary satellite or non-geostationary satellite in a frequency band in which a non-geostationary system is (or is proposed to be) licensed for feeder links shall demonstrate in its application that its proposed earth station will not cause unacceptable interference to any other satellite network that is authorized to operate in the same frequency band, or certify that the operations of its earth station shall conform to established coordination agreements between the operator(s) of the space station(s) with which the earth station is to communicate and the operator(s) of any other space station(s) licensed to use the band."

The following Rules concern inter-satellite links:

g. Add new Section 25.---, as follows:

"Inter-Satellite Service

(1) Any non-geostationary satellite communicating with other space stations may use frequencies in the inter-satellite service as indicated in Section 2.106 and does not preclude

the use of other frequencies for such purposes as provided for in several service definitions, e.g. FSS. The technical details of the proposed inter-satellite link shall be provided in accordance with 25.114 (c).

(2) Operating conditions. In order to ensure compatible operations with authorized users in the frequency bands to be utilized for operations in the inter-satellite service, these inter-satellite service systems must operate in accordance with the conditions specified in this section.

(a) Coordination requirements with federal government users.

(i) In frequency bands allocated for use by the inter-satellite service that are also authorized for use by agencies of the federal government, the federal use of frequencies in the inter-satellite service frequency bands is under the regulatory jurisdiction of the National Telecommunications and Information Administration (NTIA).

(ii) The Commission will use its existing procedures for liaison with NTIA to reach agreement with respect to achieving compatible operations between federal government users under the jurisdiction of NTIA and inter-satellite service systems through the frequency assignment and coordination practices established by NTIA and the Interdepartment Radio Advisory Committee (IRAC). In order to facilitate such frequency assignment and coordination, applicants shall provide the Commission with sufficient information to evaluate electromagnetic compatibility with the federal government use of the spectrum, and any additional information requested by the Commission. As part of the coordination process, applicants shall show that they will not cause unacceptable interference to authorized federal government users, based upon existing system information provided by the government. The frequency assignment and coordination of the satellite system shall be completed prior to grant of construction authorization.

(b) Coordination among inter-satellite service systems. Applicants for authority to establish inter-satellite service are encouraged to coordinate their proposed frequency usage with existing permittees and licensees in the inter-satellite service whose facilities could be affected by the new proposal in terms of frequency interference or restricted system capacity. All affected applicants, permittees, and licensees, shall at the direction of the Commission, cooperate fully and make every reasonable effort to resolve technical problems and conflicts that may inhibit effective and efficient use of the radio spectrum; however, the permittee or licensee being coordinated with is not

obligated to suggest changes or re-engineer an applicant's proposal in cases involving conflicts."

h. Add subsection (a)(3) to Section 25.202, as follows:

"The following frequencies are available for use by the inter-satellite service:

22.55-23 GHz
23-23.55 GHz
24.45-24.65 GHz
24.65-24.75 GHz

i. Replace subsection (c) to Section 25.208 with the following:

"In the bands 17.7-19.7 GHz, 22.55-23.00 GHz, 23.00-23.55 GHz, 24.45-24.75 GHz, the power flux density at the earth's surface produced by emissions from a space station for all conditions and for all methods of modulation shall not exceed the following values:

-115 dB(w/m^2) in any 1 MHz band for angles of arrival between 0 and 5 degrees above the horizontal plane.

-115 + 0.5 (∂-5) dB (w/m^2) in any 1 MHz band for angles of arrival ∂ (in degrees) between 5 and 25 degrees above the horizontal plane.

-105 dB (w/m^2) in any 1 MHz band for angles of arrival between 25 and 90 degrees above the horizontal plane.

5.2 Recommendations

a. Application of RR 2613

With regard to international application of RR 2613, the Working Group recommends that the United States determine its obligations under RR 2613 in the following manner. Three conditions must be met before a non-geostationary system would be required to cease or reduce transmissions in order to protect a geostationary system. First, the administrations of the systems involved must engage in bi-lateral or multi-lateral discussions and reach agreement as to a level of "accepted interference" (see RR 162). Second, after the systems are in operation, the non-geostationary system must exceed the level of interference agreed to. Third, the interference in excess of the agreed level must be caused by the failure of the non-geostationary system to maintain sufficient angular separation between the satellites of the two systems. If any of these three conditions is not met, RR 2613 cannot be invoked to affect the operations of any non-geostationary satellites.

RR 2613, as interpreted by this Working Group, provides existing non-geostationary satellite systems that operate in FSS bands with a necessary measure of protection against a demand from a future geostationary FSS system that they cease or reduce transmissions. A geostationary FSS system operator would be required to coordinate with existing non-geostationary systems to arrive at a level of "accepted" interference before any demand to cease or reduce transmissions resulting from "unacceptable" interference can be made -- a requirement that does not otherwise exist under the ITU regulations. This is a positive development for non-geostationary system operators around the world, and the Working Group recommends that the United States seek the adoption of procedures to afford balanced protection for a non-GSO system from future systems. The United States should seek to have the above interpretation of RR 2613 applied internationally.

No modifications to the Commission's rules would be needed in such cases with regard to international application of RR 2613. Section 25.111 requires applicants to provide the Commission with all information necessary to complete the IFRB processes, and subjects station licenses to additional terms and conditions pending the completion of applicable discussions with other Administrations. See 47 C.F.R. Section 25.111(b).

For purposes of the Commission's regulations, all that should be included for operators of non-geostationary and geostationary FSS systems licensed or to be licensed by the Commission is a requirement that affected operators coordinate their use of the shared bands. This requirement should take the form of a regulation in Part 25 of the FCC's rules that requires coordination between affected U.S. systems.

To address this situation, the Working Group recommends that the Commission adopt proposed rules in section 5.1.3 of this report.

b. Concerning the 5150-5250 MHz band:

The Working Group recommends that the FCC identify and/or allocate suitable spectrum below 15 GHz, and preferably below 10 GHz, for MSS/RDSS feeder links. A minimum of 66 MHZ is required to accommodate the three MSS/RDSS applicants that have developed system designs based on use of the 5150-5216 MHz band. A 100 MHz band for MSS/RDSS feeder links would allow for growth of system capacity as additional antenna beams beyond the eight per satellite assumed for RDSS are added in the 1.6/2.4 GHz bands for service links to user terminals. Architecture and service concepts dictate that the necessary spectrum be free of large populations of geostationary satellites and that it be possible to establish low-cost feeder link (gateway) earth stations in the United States without burdensome coordination with terrestrial services. The spectrum must also be available for use both within and outside the United States without significant international coordination

restrictions because of the likely expansion of the MSS/RDSS systems to global service.

If the FCC determines that the 5150-5250 MHz band is the only spectrum below 15 GHz which can satisfy the identified MSS/RDSS feeder-link requirements, the Working Group recommends that the FCC take appropriate steps with the Interdepartment Radio Advisory Committee (including the FAA) and the National Telecommunications and Information Administration (NTIA) to identify conditions that could allow sharing of that band with aeronautical radionavigation.

The FCC should make appropriate modifications to the Table of Allocations in Part 2 of its Rules and appropriate modifications to Part 25 of its Rules if a change in allocations is required to make available suitable spectrum for these MSS/RDSS feeder links.

In addition the FCC should take steps to include in proposals to future Radio Conferences revisions to the international Table of allocations consistent with any U.S. allocations for MSS/RDSS feeder links including related sharing criteria.

c. 20/30 GHz Sharing Criteria

Sharing criteria should be developed and coordination methods applied to provide for coexistence of the LEO feeder link earth stations and the fixed services. It would appear that in the band 28.5-29.5 GHz a fixed terrestrial service sharing criteria which limits the fixed service transmitter eirp to 25.3 dBW/MHz at elevations of 9° or greater would protect the LEO satellite receivers. However, fixed-service interests were not represented in the Working Group.

The Working Group recognized that there will be a need for GSO/FSS and LEO systems to coordinate their use of the frequency bands, and noted that many of the rules necessary to achieve shared use of the FSS allocations for feeder-link use already exist in Part 25 or are being proposed in a separate section of this Report. Section 25.111 requires applicants to provide the Commission with all necessary information for coordination purposes. Modification to Part 25 to provide for the geographic isolation of LEO earth stations is proposed. The Working Group recognized that information regarding FSS antennas had not previously been requested. The Working Group notes that geostationary FSS interests, other than NASA, were not represented on the Working Group.

The Working Group evaluated the FCC's pending rule-making proposal to establish the Local Multipoint Distribution Service ("LMDS") -- a cellular-like terrestrial service that would broadcast FM video and other signals between hubs spaced 12 miles apart on a grid and subscriber homes and businesses -- in the frequency bands 27.5-29.5 GHz. The Working Group concluded that FSS systems and LMDS systems are unlikely to be able to operate

compatibly in the same band, and that the establishment of the LMDS service would preempt the co-primary FSS service in 2000 MHz of the 2500 MHz allocation at 27.5-30.0 GHz, and also in 2000 MHz of the corresponding FSS downlink allocation at 17.7-20.2 GHz.

In light of the apparent inability of LMDS to share frequency bands with FSS systems (some of which are soon to be launched), and the substantial threat the proposal poses to the future of the FSS in the 20/30 GHz band, the Working Group recommends that the FCC, if it is to establish the LMDS, do so in frequency bands that are not currently allocated to the FSS. The Working Group notes that LMDS interests were not represented on the Working Group.

As a consequence of the interfering situations described above it is recommended that the best way for the Iridium earth stations to coexist with the proposed LMDS is to exclude LMDS from 29.1-29.3 GHz (200 MHz) in the FSS allocation 28.5-29.5 GHz.

d. Inter-Satellite Service

The FCC Rules, aside from the non-government allocations at 22.55-23.00 GHz, and 23.00-23.55 GHz in Section 2.106, do not explicitly address the inter-satellite service which is proposed for use by one of the MSS/RDSS applicants. Therefore it is recommended that the Rules 25.143, 25.202(3), and 25.208(c) contained in Section 5.1.3 of this Report be adopted.

ATTACHMENTS

A - List of Documents of Working Group 3.

B - List of Persons Attending Working Group 3.

C - Letter dated January 29, 1993 to William Gamble, National Telecommunications and Information Administration, from Gerald J. Markey, Manager, Spectrum Engineering and Policy Division, Federal Aviation Administration.

D - Letter dated March 18, 1993 of Arnold Aquilano, Associate Administrator for Airway Facilities, FAA, to Cheryl Tritt, Chief, Common Carrier Bureau, Federal Communications Commision

E - Schedule for TDWR Installations inthe 5600-5650 MHz band

F - Technical Charqacteristics fo TDWR Systems

ATTACHMENT A

ATTACHMENT B

Attachment A to
Annex 3
MSSAC-43.10 (Rev. 1)

Working Group 3 Document List

MSSAC/WG3

1. Working Group 3 meeting agendas
2. (Rev. 2) MSS/RDSS Feeder Link and Intersatellite Link Requirements
3. LEO/Geo satellite service sharing study (FCC)
4. NASA Interests Regarding the Work of WG-3 -- Inter-Satellite and Feeder Links (NASA)
5. Globalstar C-band Power Flux Density and Feederlink Plan (LQSS)
6. Outline of Report -- 5 GHz Band (DG A)
7. Chart: allocation and use of bands 3400 - 7075 MHz (DG B)
8. (Rev. 1) Suggested Revisions to RR 2613 (DG C)
9. (Rev. 1) Part 25 Modifications (DG E)
10. Agreement between NASA and Motorola on Intersatellite Link Frequencies (Motorola and NASA)
11. Liaison Statement from WP 8D to WP 4A -- Control of Interference in FSS Frequency Bands Used by a Mobile-Satellite Service for Feeder Links to Non-Geostationary Space Stations (FCC)
12. Letter from Comsearch to the coordinator of Working Group 3 addressing several frequency issues (Comsearch)
13. FCC public notice regarding a rule-making proposal to establish a new "local multipoint distribution service (LMDS)" in the 27.5 - 29.5 GHz band (FCC)
14. Letter from Gerald J. Markey of the FAA to William Gamble of NTIA regarding the 5 GHz band (FAA)
15. Meeting schedules for Working Group 3
16. (Rev. 5) Sharing Problems and Sharing Arrangements for the 20/30 GHz Bands (DG D)
17. (Rev. 3) (Also numbered as MSSAC-43.8) Sharing Arrangements for Intersatellite Links (DG F)
18. ACTS Frequency Plan (NASA)
19. Preliminary Assessment of NASA ACTS, Stage 4 (FCC)
20. CELSAT's Feeder Link Requirements (CELSAT)
21. Letter from Robert Bowen, Department of Communications, Canada, to the coordinator of Working Group 3 regarding feeder-link allocations in the regions of 20/30 GHz
22. (Rev. 6) (Also numbered as MSSAC-43.4) Report of Drafting Group C; draft report text (originally labeled as document 8 (Rev. 2)) (DG C)
23. Memorandum from the FAA representative to the coordinator of Working Group 3 regarding FAA plans for use of the 5150 - 5250 MHz band (FAA)
24. (Rev. 2) Outline of MSSAC Report Text to be Provided by Working Group 3
25. (Rev. 2) (Also numbered as MSSAC-43.6) Draft report text on Feeder Links in Other Bands Below 15 GHz (DG B)
26. Equipment Characteristics and Delivery Schedule: Terminal Doppler Weather Radar (FAA)

27. (Rev. 4) Draft report text on Feederlinks in the 5/6 GHz Bands (DG A)
28. Provision of Spectrum for Feeder Links of Non-Geostationary Mobile Satellites (R. Bowen/Dept. of Communications/Canada)
29. FAA edits to MSSAC/WG3-27 (FAA)
30. (Rev. 1) Use of the Same Feederlink Spectrum by Two or More CDMA LEO MSS Systems (LQSS)
31. Letter from Arnold Aquilano, Associate Administrator for Airway Facilities, Federal Aviation Administration, to Cheryl Tritt, Chief, Common Carrier Bureau, Federal Communications Commission, regarding the 5150 - 5250 MHz band (FAA)
32. C-band Feederlinks Crucial to Globalstar's Service Concept (LQSS)
33. Impact on Systems when using Feeder Links Greater than 15 GHz (Ellipsat)

Documents of Working Group 3 are variously identified with the prefixes "MSSAC/WG3", "MSSAC/IWG3", "IWG 3", and "IWG-3".

Parentheses at end of document description contain identification of source of document. The letters "DG" denote a drafting group of the working group. Documents without source identification are contributions of the working group coordinator.

Numbers in parentheses at the beginning of document description indicate last revision number of document; other documents were not revised.

WORKING GROUP 3
MSS ABOVE 1 GHZ NEGOTIATED RULEMAKING COMMITTEE

Consolidated List of Persons Attending

Melvin Barmat	Jansky/Barmat Telecommunications (Motorola)
Richard Barnett	Telecomm Strategies (TRW)
Stephen Baruch	Leventhal, Senter and Lerman (TRW)
Jeffrey Binckes	Comsat Mobile Communications
William M. Borman	Motorola, Inc.
John Brosius	Ellipsat Corporation
Steve Carter	Qualcomm, Inc. (LQSS)
Steve Clark	Motorola, Inc.
David Donohoe	Comsearch
Ken Engle	Motorola
James G. Ennis	Fletcher, Heald, and Hildreth (Motorola)
Dale Fallimore	Loral/Qualcomm
Dr. Bob Filep	Communications 21 Corporation
James P. Fitzgerald	Comsearch
Robert Frazier	FAA/ASM-500, Spectrum Engineering and Planning Division
R. Gould	Telecom Systems (CORF)
John Hatlelid	Motorola, Inc.
Jack Haughton	Ellipsat Corporation
Donald Jansky	Jansky/Barmat Telecommunications (Motorola)
Kevin Kelley	Qualcomm, Inc.
Michael Kennedy	Motorola, Inc.

Len Kolsky	Motorola, Inc.
Barry Lambergman	Fletcher, Heald and Hildreth (Motorola)
Michael Lehmkuhl	Goldberg, Godles, Wiener & Wright (European Community)
Ron Lepkowski	Constellation Communications
Steven Lett	Department of State
Mark Lewellen	ARC (NASA)
Alfred Mamlet	Steptoe & Johnson (Motorola)
Ken Manning	Ellipsat Corporation
Robert Mazer	Nixon, Hargrave, Devans & Doyle
Dr. Edward F. Miller	NASA, LeRC
Dr. L. Warren Morrison	Celsat, Inc.
Gerald Munson	Motorola, Inc.
Jack Naughton	Ellipsat
Harry Ng	Federal Communications Commission
Sam Nguyen	Comsat
David D. Otten	Celsat, Inc.
Cahit Ozbay	W.L. Pritchard & Co. (LQSS)
Brian Ramsay	NTIA/OSM
Alan Rinker	ARC (NASA)
Jill Stern	Shaw, Pittman, Potts & Trowbridge
David Struba	NASA
Leslie Taylor	Leslie Taylor Associates (LQSS)
William M. Titus	FAA
Tom Tycz	Federal Communications Commission
Michael Ward	American Mobile Satellite Corporation

ATTACHMENT

MSSAC WG3/14

JAN 29 1993

INFORMATION: Proposed Use of the
5150-5250 MHz band for Big Low Earth
Orbiting (LEO) Satellite System Feeder Links

Manager, Spectrum Engineering and Policy
Division, ASM-500

William Gamble, National Telecommunications
and Information Administration (NTIA)

We are writing this letter to voice our continued opposition to the proposed use of the 5150-5250 MHz band (specifically, the 5150-5216 MHz portion of this band) for feeder links for proposed Big LEO systems. We understand that at least two of the proposals from industry include a satellite-to-ground feeder link in the 5150-5250 MHz band. At the initial Federal Communication Commission (FCC) Federal Advisory Committee meeting, Tom Tycz, Deputy Chief, Domestic Facilities Division of the FCC, stated that this band is not open as an option for Big LEO feeder links. We need NTIA's continued support for this position to protect this band for future aeronautical safety related services, which the FAA is investigating.

As you are well aware, the use of the 5150-5250 MHz band for Big LEO feeder links was proposed by industry to be included in the United States (U.S.) position for the 1992 World Administrative Radio Conference (WARC-92). The FAA opposed this use. This WARC-92 position of maintaining the present allocation was established after much coordination, and, in our view, should still represent the Government position in this matter.

As we voiced in the WARC-92 preparation, the problem with LEO feeder link use is that there is expected to be an undetermined (and possibly unrestricted) number of ground installations, and the ground station antennas would be operating over many elevation and azimuth angles. This means that many to/from aircraft communications, navigation, and surveillance applications could essentially be precluded by the implementation of LEO feeder link use. Satellite ground stations would need to be protected from civil aviation ground transmitters. But, more importantly, use of this band for satellite-to-ground station LEO feeder links could preclude civil aviation applications requiring transmissions from

aircraft for up to hundreds of miles from each satellite ground station (since the aircraft transmissions could cause interference to the satellite ground stations).

The FAA is investigating a number of applications for this band. We have shared this information with other states at the 1990 International Civil Aviation Organization Communications/Meteorology/Operations Divisional Meeting (9/90), and during the preparation of the U.S. Position for WARC-92. The potential applications include Terminal Doppler Weather Radar, Global Navigation Satellite System (GNSS) related transmissions (for differential GNSS applications), and for Automatic Dependent Surveillance (ADS). The GNSS function may include transmissions from the aircraft to ground to acknowledge and confirm (for system integrity) ground to aircraft transmissions. In addition, the ADS application will require aircraft to ground transmissions to , e.g., confirm ADS capability level, etc.

The FAA supports spectrum utilization efficiency, and, as such, recognizes the potential of the 5150-5250 MHz band to satisfy aviation safety needs for a potentially large number of users.

In this regard, and considering that LEO spacecraft would be relatively close to the earth (thus requiring significantly less transmission power to provide a satisfactory communications link), we believe that it would be in the best interests of the U.S. community to seek the use of a different band for these LEO feeder link uses. There should be a number of higher frequency bands where transmitter/receiver technology should be sufficiently technically mature for LEO feeder link purposes. In this regard, we would seek your help, to the extent that it is needed, to find an alternate band for The Big LEO feeder links.

We will continue to keep the NTIA advised of the development of civil aviation applications that anticipate using the 5150-5250 MHz band.

ORIGINAL SIGNED BY:
GERALD J. MARKEY
Gerald J. Markey

cc: Mr. Thomas Tycz, Deputy Chief,
Domestic Facilities Division, FCC

ASM-520:BFrazier:tap:267-9722:1/29/93\NTIA3.2DO (disk)

ATTACHMENT D

MSAC/WG-3 ~~~

3/22/93

993

Ms. Cheryl Tritt
Chief, Common Carrier Bureau
Federal Communications Commission
1919 M Street, NW.
Washington, DC 20554

Dear Ms. Tritt:

I am writing this letter to voice our continued need to protect the 5150-5250 MHz Aeronautical Radionavigation band for unmet national airspace system (NAS) aeronautical safety service requirements. We have been working in good faith in the Federal Communications Commission (FCC), "Big Leo" negotiated rulemaking process. However, we must have a recognition that the 5150-5250 MHz band is not available for feeder links for "Big Leo" satellite systems.

The Federal Aviation Administration (FAA), is conducting advanced planning for a number of applications for this band as part of the NAS Capital Investment Plan. These applications include terminal doppler weather radar (TDWR), differential global positioning system (DGPS), pseudo satellite ground-based stations to be used in conjunction with the GPS or DGPS, and automatic dependent surveillance (ADS) applications. The ADS applications would include both ground-based and airborne originated transmissions.

I would like to emphasize the importance of the 5150-5250 MHz band to FAA and United States (U.S.) civil aviation by reviewing one important requirement. At the International Civil Aviation Organization (ICAO) Assembly meeting in latter 1992, the U.S. demonstrated to the world the potential capabilities of the global navigation satellite system (GNSS). The U.S. convinced the ICAO Assembly of the reality of this vision. The ICAO Assembly subsequently agreed to hold a special ICAO divisional meeting in the 1995 time period to review recommendations on the use of GNSS for meeting future enroute and instrument landing system requirements. GPS and Russia's satellite navigation system (called GLONASS) are the principal candidate GNSS systems for satisfying these requirements.

In addition, as you are aware, GPS initiatives are being undertaken by the joint Government/industry Satellite Operational Implementation Team. We must have adequate and appropriate

frequency spectrum to satisfy these GNSS related requirements, including pursuing international standards to ensure international interoperability. FAA needs the 5150-5250 MHz band for these GNSS applications.

I would now like to illustrate how we have worked to serve the broader U.S. telecommunication interests. In previous communications with the National Telecommunications and Information Administration, we presented a summary of the findings of an FAA sponsored study that provided an initial analysis of the possibilities of using the upper portion of the 1610-1626.5 MHz band for GPS related satellite applications.

The FAA is aware of the importance of the new "Big Leo" satellite initiatives to the U.S., and the requests from U.S. companies to use a band segment in the 1610-1626.5 MHz band above that used by GLONASS. Therefore, in order to help serve the broader U.S. telecommunication interests, the FAA is moving the GPS related satellite requirements out of the upper portion of the 1610-1626.5 MHz band. The 5150-5250 MHz band is being considered as an alternative for meeting GPS related requirements.

In closing, I want to stress that we will continue to participate in the "Big Leo" negotiated rulemaking process in a cooperative manner. We have already provided technical information on the TDWR to the committee. Additional information on the other applications is forthcoming. However, I must voice, on behalf of FAA, that the 5150-5250 MHz band must be preserved to meet civil aviation safety service requirements, consistent with the present national and international allocations.

Sincerely,

Arnold Aquilano
Associate Administrator for
Airway Facilities

cc: ASM-500/520, ASM-1, AAF-1, D. Parlow (NTIA), J. Dorffler, ARD-70 & B. Dixon, AAF-5
ASM-500:J.Markey:ttc:x79710/2-25-93/S:XX TRITT.1:Retyped 3/1:Retyped 3/3:

ATTACHMENT

TERMINAL DOPPLER WEATHER RADAR (TDWR) 01-05-93
EQUIPMENT DELIVERY SCHEDULE

TDWR No.	SITE LOCATION	FAA ID	COUNTY	ST	REG	AIRWAY FACIL. SECTOR	COST CENT CODE		EQUIPMENT DELIVERY DATE	CAI COMP. DATE	IOS/EA DELIVERY DAY/YEAR	DISPLAY DELIVERY DAY/YEAR	NORTH LAT.	WEST LONG.	TOWER HGT. (m)	ELEV (MSL) (FT)	FREQ. (MHZ)	D & D FROM AIRPORT (NM)
1	FAA AERONAUTICAL CTR	OKE	Oklahoma City	OK				C	12-Dec-92	20-May-92	08-Jun-90	N/A	352419	973731	20	1286	5610	1.4 NW
								O	02-Dec-91									
								R	09-Sep-91									
2	MEMPHIS	MEM	Shelby	TN	SO	MEMPHIS	050C	C	02-Jun-92	02-Dec-92	01-Feb-91	28-Jul-91	345345	895934	30	370	5610	9.2 S-SW
								O	02-Oct-92									
								R	09-Aug-92									
3	HOUSTON (INTERCONT.)	IAH	Harris	TX	SW	HOUSTON	0366	C	02-Sep-92	04-Jun-93	01-Feb-91	28-Jul-91	300553	953401	25	155	5605	13.4 NW
								O	02-Oct-92									
								I	09-Aug-92									
4	ATLANTA	ATL	Fulton	GA	SO	ATLANTA	041E	C	02-Jun-93	02-Apr-93	28-Feb-91	10-Aug-91	333040	841544	30	962	5615	8.0 E
								O	09-Mar-93									
								I	09-Jun-93									
5	WASHINGTON NAT'L	DCA	Arlington	VA	EA	CAPITAL	0405	C	02-Jul-93	02-Oct-93	28-Feb-91	28-Jul-91	384532	765746	25	260	5615	6.5 NE
6	CHICAGO (O'HARE)	ORD	Cook	IL	GL	CHICAGO	0659	C	02-Jul-93	02-Oct-93	04-Apr-91	10-Aug-91	414709	875129	25	645	5615	10.7 E
7	DENVER	DEN	Denver/Adams	CO	NM	DENVER	0310	C	02-Aug-93	02-Nov-93	09-Oct-91	06-Jan-92	394340	1045737	15	5635	5615	10.4 NE
8	NEW ORLEANS	MSY	Jefferson	LA	SW	NEW ORLEANS	0402	C	02-Aug-93	02-Nov-93	04-Apr-91	19-Oct-91	[illegible]	902611	25	1	5645	7.6 W
9	SAINT LOUIS	STL	St. Louis	MO	CE	ST LOUIS	0330	C	02-Aug-93	02-Nov-93	04-Apr-91	19-Sep-91	[illegible]	[illegible]	25	550	5646	6.9 NW
10	ORLANDO	MCO	Orange	FL	SO	TAMPA	046L	C	02-Sep-93	02-Dec-93	08-May-91	19-Sep-91	[illegible]	[illegible]	25	73	5640	5.0 S
11	TAMPA	TPA	Hillsboro.	FL	SO	TAMPA	[illegible]	C	02-Sep-93	02-Dec-93	16-Jul-91	19-Oct-91	275134	[illegible]	20	144	5620	7.0 E
12	MINNEAPOLIS	MSP	Hennepin	MN	GL	MINNESOTA	0670	C	02-Sep-93	02-Dec-93	08-May-91	19-Oct-92	446719	930217	20	950	5610	9.6 NE
13	DETROIT	DTW	Wayne	MI	GL	MICHIGAN	061V	C	02-Oct-93	02-Jan-94	09-Nov-91	12-Jun-92	420041	[illegible]	30	695	5615	9.0 NW
14	MIAMI	MIA	Dade	FL	SO	MIAMI	062C	C	02-Oct-93	02-Jan-94	16-Jul-91	10-Aug-91	254525	[illegible]	30	5	5605	11.0 W
15	HOUSTON (HOBBY)	HOU	Harris	TX	SW	HOUSTON	0366	C	02-Oct-93	02-Jan-94	25-Sep-91	19-Oct-92	[illegible]	951429	20	47	5645	6.0 S-SE
16	PITTSBURGH	PIT	Allegheny	PA	EA	PITTSBURGH	[illegible]	C	02-Nov-93	02-Feb-94		12-Jun-92			30			
17	PHILADELPHIA	PHL	Phila.	PA	EA	TRI-STATE	0444	C	02-Nov-93	02-Feb-94	09-Nov-91	10-Aug-91	395405	750406	30	40	5610	9.4 [illegible]
18	ANDREWS AF BASE	ADW	P. Georges	MD	EA	CAPITAL	0401	C	02-Nov-93	02-Feb-94	09-Dec-91	19-Oct-92	[illegible]	765041	30	235	5615	6.0 S
19	PHOENIX	PHX	Maricopa	AZ	WP	PHOENIX	0502	C	02-Dec-93	02-Mar-94	09-Dec-91	09-Mar-92	[illegible]	1120046	15	1025	5610	7.0 W
20	NEWARK	EWR	Essex	NJ	EA	TRI-STATE	0461	C	02-Dec-93	02-Mar-94	09-Dec-91	06-Jan-92	[illegible]	741614	30	20	5620	7.4 SW
21	OKLAHOMA CITY	OKC	Oklahoma	OK	SW	OKLA. CITY	[illegible]	C	02-Dec-93	02-Mar-94	09-Jan-92				15			
22	BOSTON	BOS	Suffolk	MA	NE	BOSTON	[illegible]	C	02-Jan-94	02-Apr-94	20-Jan-92	09-Mar-92	[illegible]	[illegible]	30	151	5610	12.7 S-SE
23	CHARLOTTE	CLT	Mecklenburg	NC	SO	CHARLOTTE	044C	C	02-Jan-94	02-Apr-94	20-Jan-92		[illegible]	[illegible]	30	[illegible]	[illegible]	9.6 [illegible]
24	KANSAS CITY	MCI	Platte	MO	CE	SAINT LOUIS	[illegible]	C	02-Jan-94	02-Apr-94	20-Jan-92		[illegible]	944439	15	1040	[illegible]	11.7 [illegible]
25	DALLAS(LOVE FIELD)	DAL	Dallas	TX	SW	DFW	[illegible]	C	02-Feb-94	02-May-94	10-Feb-92		[illegible]	[illegible]	30	345	[illegible]	7.7 NW
26	TULSA	TUL	Tulsa	OK	SW	OKLA. CITY	0544	C	02-Feb-94	02-May-94	14-Feb-92		[illegible]	[illegible]	30	775	[illegible]	8.3 [illegible]
27	LOUISVILLE	SDF	Jefferson	KY	SO	COVINGTON	[illegible]	C	02-Feb-94	02-May-94	09-Mar-92		[illegible]	[illegible]	30	618	5644	9.0 [illegible]
28	DAYTON	DAY	Montgomery	OH	GL	OHIO	[illegible]	C	02-Mar-94	02-Jun-94	09-Mar-92		400119	840725	25	[illegible]	5640	8.5 [illegible]
29	BALTIMORE	BWI	A. Arundel	MD	EA	CAPITAL	[illegible]	C	02-Mar-94	02-Jun-94		09-Mar-92			30			
30	WEST PALM BEACH	PBI	Palm Beach	FL	SO	MIAMI	[illegible]	C	02-Mar-94	02-Jun-94	09-Apr-92		264103	[illegible]	30	22	[illegible]	9.2 [illegible]
31	WASH. DC (DULLES)	IAD	Loudoun	VA	EA	CAPITAL	0404	C	02-Apr-94	02-Jul-94	09-Apr-92		[illegible]	773046	30	360	[illegible]	9.0 [illegible]
32	FAA PGF Facility	OKE	Ok. City	OK				C	02-Apr-94	02-Jul-94	09-Apr-92	N/A	[illegible]	973[illegible]	25	1290	5620	8.4 [illegible]
33	RALEIGH-DURHAM	RDU	Wake	NC	SO	RALEIGH	044C	C	02-Apr-94	02-Jul-94	09-May-92		[illegible]	[illegible]	30	400	5647	8.6 [illegible]
34	NASHVILLE	BNA	Davidson	TN	SO	MEMPHIS	[illegible]	C	02-May-94	02-Aug-94	09-May-92		[illegible]	[illegible]	25	720	[illegible]	8.0 S
35	NEW YORK (JFK)	JFK	Queens	NY	EA	METRO	0412	C	02-May-94	02-Aug-94	08-Jun-92	06-Jun-92	403916	735104	25	30	5647	12.1 E
36	DALLAS-FORT WORTH	DFW	Dallas/Tarr.	TX	SW	DFW	0265	C	02-May-94	02-Aug-94	08-Jun-92		[illegible]	[illegible]	3	554	5640	11.7 [illegible]
37	MILWAUKEE	MKE	Milwaukee	WI	GL	WISCONSIN	[illegible]	C	02-Jun-94	02-Sep-94	23-Jun-92		420911	[illegible]	30	[illegible]	[illegible]	10.1 [illegible]
38	COVINGTON/CINCINNATI	CVG	Boone	KY	SO	COVINGTON	048C	C	02-Jun-94	02-Sep-94	07-Jul-92		385552	843440	25	[illegible]	5610	9.0 [illegible]
39	WICHITA	ICT	Sedgwick	KS	CE	WICHITA	0426	C	02-Jun-94	02-Sep-94	31-Jul-92		[illegible]	[illegible]	20	1270	[illegible]	8.6 S
40	CLEVELAND	CLE	Cuyahoga	OH	GL	OHIO	[illegible]	C	02-Jul-94	02-Oct-94	05-Aug-92		411723	[illegible]	30	[illegible]	5645	10.2 [illegible]
41	CHICAGO (MIDWAY)	MDW	Cook	IL	GL	CHICAGO	[illegible]	C	02-Aug-94	02-Nov-94	11-Aug-92		413[illegible]	[illegible]	30	[illegible]	5645	8.2 S-SW
42	SAN JUAN	SJU		PR	SO	SAN JUAN	[illegible]	C	02-Aug-94	02-Nov-94	11-Aug-92		[illegible]	[illegible]	25	60	5610	10.3 [illegible]
43	SALT LAKE CITY	SLC	Salt Lake	UT	NM	SALT LAKE	[illegible]	C	02-Sep-94	02-Dec-94	07-Sep-92		[illegible]	1120[illegible]	15	4375	5610	8.4 S
44	FORT LAUDERDALE	FLL	Broward	FL	SO	MIAMI	[illegible]	C	02-Sep-94	02-Dec-94	22-Sep-92	10-Aug-91	[illegible]	[illegible]	30	6	5645	10.2 NW
45	INDIANAPOLIS	IND	Marion	IN	GL	INDIANA	[illegible]	C	02-Sep-94	02-Dec-94	30-Sep-92		[illegible]	[illegible]	25	750	5605	9.0 [illegible]
46	NYC (LA GUARDIA)	LGA	Queens	NY	EA	METRO	0415	C	02-Oct-94	02-Jan-95		06-Jun-92	[illegible]	[illegible]	30	[illegible]	[illegible]	
47	COLUMBUS	CMH	Franklin	OH	GL	OHIO	0427	C	02-Oct-94	02-Jan-95			400[illegible]	[illegible]	20	1035	[illegible]	

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ATTACHMENT 1

TRANSMITTER EQUIPMENT CHARACTERISTICS

IW63-26

1. Nomenclature/Model No. Terminal Doppler Weather Radar Transmitter	1a. Manufacturer's Name TBD
2. System Nomenclature Pulse Doppler Weather Radar	3. Transmitter Type Pulse Doppler Radar
4. Tuning Range 5.60 - 5.65 GHz	5. Method of Tuning Change Crystal
6. RF Channeling Capability Single Channel/Frequency	7. Frequency Stability 35-45PPM
8. Emission Designation(s) 3M26PON	9. Emission Bandwidth ☒ Calculated ☐ Measured -3dB 1.4 - 1.57 MHz -20 dB 3.26 - 3.65 MHz -40 dB 11.32 - 12.66 MHz -60 dB 20.27 - 22.66 MHz Occupied Bandwidth N/A (99%)
10. Filter employed: ☐ Low Pass ☐ High Pass ☒ Band Pass ☐ None	
11. Maximum Bit Rate N/A	12. Maximum Modulation Frequency N/A
13. Pre Emphasis ☐ Yes ☒ No	14. Deviation Ratio N/A
15. Power (a) Carrier ____ (b) Mean ____ (c) Peak Envelope 750kw - 1.2mw	16. Pulse Characteristics (a) Rate 700-3000PPS (See Remarks) (b) Width 1-1.5 usec (c) Rise time 0.1-0.15 usec (See Remarks) (d) Fall time 0.1-0.15 usec (See Remarks) (e) Compression Ratio N/A
17. Output Device Klystron	
18. Spurious Level -80dBc	19. Harmonic Level (a) 2nd -80 dBc (b) 3rd -80 dBc (c) Other -80dBc
20. FCC Type Acceptance No.	

21. Remarks:

16.(a)PRF Variable based on algorithm e.g. targets, velocities, etc.

16.(c)(d) Must comply with RSEC Criteria C.

Terminal Doppler Weather Radar Receiver	TBD
2. System Nomenclature Terminal Doppler Weather Radar	1. Receiver Type Superheterodyne for Pulse Doppler Radar
4. Tuning Range 5.60 - 5.65 GHz	5. Method of Tuning Change Crystal
6. RF Channeling Capability Single Channel	7. Frequency Stability Exactly Matched to Transmitter (35-65 PPM)
8. Emission Designation(s) 3M26PON	9. RF Selectivity ☒ Calculated ☐ Measured (a) -3 dB TBD (See Remarks) (b) -20 dB TBD (c) -60 dB TBD (d) Type of preselection used None
10. IF Selectivity (a) -3 dB TBD (See Remarks) (b) -20 dB TBD (c) -60 dB TBD	
11. Maximum Bit Rate N/A	12. Maximum Post Detection Frequency N/A
13. De-emphasis Available ☐ Yes ☒ No	14. Minimum Post Detection Frequency N/A
15. IF Frequency TBD (See Remarks)	16. Sensitivity (a) -109 dBm (b) Criteria 0dB S/N (c) Noise Figure 2.5 - 3.5 dB
17. Oscillator Tuned Above tuned frequency ☐ Below tuned frequency ☐ Either above or below tuned frequency ☒	
18. Spurious Rejection 60dB	19. Image Rejection 50dB

20. Remarks

9. Selectivity for (a) dependent on MFR design; to be commensurate with transmitter BW.

10. Selectivity for (a) dependent on MFR design; to be commensurate with transmitter BW.

15. IF frequency dependent on MFR design (Approx. 30 to 90 MHz)

ANTENNA EQUIPMENT CHARACTERISTICS

1. Nomenclature Model Number Terminal Doppler Weather Radar Antenna	1a. Manufacturer's Name TBD
2. System Nomenclature Terminal Doppler Weather Radar	3. Type Parabolic, Center Fed (See Remarks)
4. Frequency Range 5.60 - 5.65 GHz	5. Polarization Linear (Hor, Vert) Circular
6. Gain (a) Main Beam 50dB (b) Side Lobe -27dB Median gain <-10 dBi	7. Scan Characteristics (a) Type Vertical & Horizontal (b) Vertical Scan (1) Max. Elev. 60 Degrees (2) Min. Elev. -1 Degree (3) Scan Rate 2.5 scans/min (c) Horizontal Scan (1) Sector Scanned 0 to 360 Degrees with sector blanking capability (2) Scan rate 5 RPM
8. Beamwidth (a) Horizontal 0.5 Degree (b) Vertical 0.5 Degree	

9. Remarks

Terminal Doppler Weather Radar specification will allow the manufacturer to have a horizontal beam width of 0.5 degrees. This will allow a parabolic dish, center feed antenna of 8.5 meters diameter to meet the requirements. Other designs possible but not probable.